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There's More to the Story: Shedding Light on Conflict Species Identification and the Unknown Impacts of Conflict with Predators

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THERE'S MORE TO THE STORY: SHEDDING LIGHT ON CONFLICT SPECIES IDENTIFICATION AND THE UNKNOWN IMPACTS OF CONFLICT WITH PREDATORS

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ABSTRACT

Local people living near protected areas are often dependent on these areas for livestock grazing and forest product collection, and therefore may face conflict with predators. The direct impacts of predator conflict (i.e., injury/death of livestock/humans) have been widely researched, however, it is the indirect impacts (e.g., fear, stress, sleep deprivation, increased disease vulnerability, family dynamics, and time/effort of pursuing compensation), that have received little attention on general. Further, within human-wildlife conflict (HWC) literature there seems to be an underlying assumption that research participants are able to correctly identify the wildlife species that they are reporting caused both direct and indirect impacts. To address knowledge, attitudes, and indirect impacts of human-predator conflict (HPC) as well as predator identification ability, we interviewed people in 54 villages near Kanha National Park (KNP), India (n= 437). We used participants' overall knowledge of, and overall attitudes towards tigers, and aggregate indirect impacts experienced from HPC as dependent variables in linear regression models to find the sociodemographic factors that influence knowledge, attitudes, and impacts. Similarly, we used the sociodemographic variables to predict participant's ability to identify photographs of 9 predator species found in KNP in logistic regression models. Our results showed that all participants experienced at least 1 indirect impact, with female and younger participants more likely to experience indirect impacts and to have lower levels of knowledge about tigers than others. Attitudes towards tigers were positive, overall, despite indication of impacts from HPC in our sample and study area. Sloth bears, followed by tigers and leopards, were most likely to be identified

correctly by participants, and jackals were least likely to be identified correctly. Overall, we conclude that educational programs aimed at certain sociodemographic groups could be implemented to fill knowledge gaps and correct misconceptions, thereby improving attitudes. Further research should be done to determine the resources required for mitigation of indirect impacts of HPC on local people.

DEDICATION

I dedicate this thesis to all those who have supported me along the way, especially my inimitable parents.

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BACKGROUND

Bengal tigers (*Panthera tigris tigris*; IUCN Redlist: Endangered) and leopards (*Panthera pardus fusca*; IUCN Redlist: Vulnerable), which share similar habitats, have lost 41% of priority landscapes in India due to human encroachment and deforestation since 2006 (IUCN Redlist 2016; Dutta et al. 2013). There are approximately 2,000 tigers and 8,000 leopards surviving in India today (Wildlife Protection Society of India n.d.; IUCN Redlist 2016), and their current populations are at a historical low (IUCN Redlist 2016). The growing global human population, along with the loss of habitat worldwide, has resulted in an increase in contact between predators and humans, and this contact may result in conflict. The majority of protected areas in India are surrounded by high levels of human density (i.e., more than three million people; Chowdhury et al. 2008). This conflict is particularly high in KNP, where the rate of depredation of livestock by tigers and leopards the highest in India (Karanth et al. 2013; Miller et al. 2015).

In 1973 Kailash Sankhala developed the concept of Project Tiger, and with the help of then Prime Minister Indira Gandhi, created nine tiger reserves to preserve critical tiger habitat by eliminating human influence inside the core areas. KNP one of the national parks converted into a tiger reserve in the launch of Project Tiger, is the largest national park in Central India. Forty villages, which were located within the national park, had to be relocated when the reserve was created. While, there are no people living within the park boundaries today, with the exception of forest guard camps, over 120,000 people live within close proximity of the park, including many in the buffer zone (Negi and Shukla 2012).

According to Negi and Shukla (2012), there are approximately 151 sloth bears, 89 tigers, 78 leopards, 401 dholes, and 353 jackals living in KNP. Additionally, KNP is inhabited by at least 4 other predator species that have the potential to be involved in conflict (i.e., Bengal fox, jungle cat, hyena, and wolf).

Human-wildlife conflict (HWC) can impact both wildlife and people who share habitat in and around protected areas. In the past, researchers have focused on the direct impacts of HWC and have relied on the ability of local people to identify conflict species correctly. Our study assessed the direct and indirect impacts of human-tiger conflict as well as locals' knowledge of and attitudes towards tigers and (Chapter 1). Further, we assessed KNP locals' ability to identify 9 predator species found in KNP (Chapter 2). In both chapters we suggest future research and education initiatives that can help inform and alleviate wildlife-related issues in KNP.

CHAPTER ONE

IDENTIFYING THE CULPRIT: WILDLIFE SPECIES IDENTIFICATION IN HUMAN-WILDLIFE CONFLICT RESEARCH

Introduction

Human-wildlife conflict (HWC), and the damage associated with it, is a pervasive issue globally. Such damage can be caused by nearly any species, from insects to megafauna, can take a multitude of forms, and can result in varying degrees of severity. Damage caused by wildlife can have an impact on humans both directly (i.e., injury or death of humans or livestock, physical damage to other property) and indirectly (e.g., fear, stress, sleep deprivation, increased disease vulnerability, family dynamics, and time/effort of pursuing compensation; Dotson et al. In prep., Sampson et al. In prep.). The severity of such damage can range from inconsequential to total devastation.

The damage caused by wildlife may weaken local support for conservation, manifesting as disregard for threats associated with habitat degradation and as retaliation for damage caused by wildlife (Ogra 2009). Predators, in particular, are vulnerable when living in habitats near increasing human populations, as people fear they may attack local people or livestock (Woodroffe 2000). Decreasing populations of predator species worldwide means that it is critical that reporting of conflict species is as accurate as possible.

There are two classifications of accurate methodologies to identify damage-causing wildlife species, technology and personal accounts. Technology (e.g., camera traps) can be used to capture an incident digitally, if set up in the right place at the right time. When available, technology can provide conclusive evidence of the responsible species, and, in some cases, the individual offending animal. Predator scat can also be tested to determine what predators are consuming. Through their analysis of scat, Acha, et al. (2017) found livestock to be over half of the spotted hyena's diet in Ethiopia.

Visual observations serve as personal accounts of the species performing the damage, whether the observer sees the animal in the act or inspects wildlife signs (e.g., scat, pugmarks and teeth marks) left at the scene that provide evidence of the responsible species. In the case of damage caused by wildlife, a person may report their personal account of damage experienced in order to receive compensation. However, for various reasons, claims for compensation may not be reported (Bond and Mkutu 2018; Miller et al. 2016b; Barua et al. 2013; Karanth et al. 2012; Ogra and Badola 2008). Given that personal accounts from local people living among the wildlife may go unreported, wildlife professionals must make a concerted effort to communicate with locals about their experiences in order to gain their insight. This communication between wildlife professionals and those witnessing or experiencing conflict can take the form of complaints, reports, surveys, or interviews.

When the communication takes the form of surveys or interviews as part of scientific research, an integral part of producing data that is reflective of the conflict is including methodology to confirm that the witness is able to correctly identify the species

(hereafter referred to as "correct ID"). What is often described in HWC literature is that participants are asked questions about conflict with a particular species or to report which species caused the conflict, without verification of correct ID. McKay et al. (2018), Struebig et al. (2018), Muriuki et al. (2017), and Goodale et al. (2015), to name a few studies, all describe methods wherein the participants are asked about conflict, but in all cases, the methods do not include any efforts to verify the participant's identification accuracy. Such methodology is infrequently included within human-predator conflict (HPC) and predator damage literature, suggesting that there may be an underlying assumption that participants are able to accurately identify the species involved in the conflict. Without such identification measures, researchers will not be able to confirm that their results are conclusively reflecting the conflict.

Relatively few studies, that we are aware of, include methodology to test the assumption and verify identification accuracy. Dickman et al. (2014) showed Tanzanian participants photographs of 19 native species; on average, participants were able to identify 11 of the species, but often confused cheetahs with leopards (Dickman et al. 2014). In South Africa, Lagendijik and Gusset (2008) asked residents from local communities to identify the predator via photographs; locals were able to identify approximately half of the species, despite the majority of locals indicating that they could differentiate between all predators (Lagendijik and Gusset 2008). Babrgir et al. (2015) asked Iranian participants to identify photographs of leopards; nearly 70% of participants were able to do so. In a human-predator conflict study in Panna Tiger Reserve, India,

Kolipaka et al. (2015) found that less than half of pastoralists were able to identify tigers and leopards correctly.

Some studies specifically highlight the relationship between the ability to identify damage species and the reliability of damage reporting. Hockings and McLennan (2012) suggest that local people's reports of crop-raiding may be unreliable due to their misidentification of species and their potential exaggeration of damage due to the availability of damage compensation. Further, Macgowan et al. (2006) found that in Indiana, participants overestimated damage done by deer, when field surveys indicated otherwise.

The repercussions of research that does not have methods in place for confirming the ability of subjects to identify conflict species can be significant. Inaccurate blame on species may lead to negative attitudes toward the species (Macgowan et al. 2006), the revenge killing of the species (Romanach et al. 2007; Sillero-Zubiri et al. 2006), or government-sanctioned population reduction or removal programs (e.g., Attia et al. 2018). The actions taken by the government, non-governmental organizations, and locals due to misidentification of conflict-species can cause long-lasting damage to populations of species and local perceptions towards species.

Negative attitudes are a particular issue in cases of conflict with predators (Macgowan et al. 2006), because such attitudes may lead to actions against predators. An often-cited consequence of negative attitudes towards predators is retaliatory killings of predators following a depredation event on livestock or people (e.g., Miller et al. 2016; Silwal et al. 2016; Romanach et al. 2007; Woodroffe et al. 2005; Ogada et al. 2003).

Romanach et al. (2007) found that half of the local people who experienced livestock loss from predators laced livestock carcasses with poison, indiscriminately killing predators, which can reduce the effectiveness or even cancel out wildlife conservation efforts. In southern Kenya, Rodriguez (2007) found that despite tolerance for predators due to a compensation program, negative attitudes and retaliatory killings endured.

In addition to retaliation on individual predators due to negative attitudes, unforeseen repercussions may surface when negative attitudes towards predators continue to fester. Gore et al. (2005) indicated that negative human-wildlife encounters often received media coverage, which can cause stakeholders to become more or less vocal about future management decisions. In a study focused on Michigander's attitudes towards predators, Hook and Robinson (1982) found that while attitudes were slightly positive overall, participants belonging to certain sociodemographic groups (e.g., rural, hunters) were less likely to have a positive towards predators than others. Further, Hook and Robinson (1982) suggest that deeply ingrained negative attitudes towards predators have contributed to failure of wolf reintroduction in the past. Another study found that Indian school children whose parents have sustained substantial injuries from predators have had to drop out of school due to teasing from other children (Silwal et al. 2016). This teasing may have caused negative feelings in these children, potentially expressing itself as revenge killing in the future (Silwal et al. 2016).

Negative attitudes towards wildlife can also lead to the use of terms with undesirable connotations towards wildlife, such as pests or nuisance animals, which, in themselves, can further perpetuate both negative attitudes and actions against wildlife.

Goodale et al. (2015) asked participants to identify "nuisance species," admitting that they were using an inherently negative construct; the authors stated that this negative framing led to an "overwhelmingly negative perception of all listed species." In a review of human-shark interaction literature, Neff and Heuter (2013) indicate that even using the word "attack" can perpetuate fear of death.

Further, the misidentification of species causing conflict may also lead to unwarranted negative feelings towards a non-problematic species, which may impact local people's participation in management conservation programs (Macgowan et al. 2006). Overtime, these misplaced negative attitudes may result in the killing of non-problematic individuals (Sillero-Zubiri et al. 2006), as well as a suite of other issues including unsuccessful management (Macgowan et al. 2006) and mitigation methods (Attia et al. 2018; Miller et al. 2016).

We add to the literature on HPC with a case study of people living in and around Kanha National Park (KNP), India. Our research objectives were to: 1) assess participant's ability to identify predator species found in and around KNP and 2) determine the factors influencing the correct identification of species.

Methods

Study Area

KNP (22.3345° N, 80.6115° E), in Madhya Pradesh India, contains 2,074 km^2 of protected habitat. The protected habitat of KNP is composed of a limited-use, interior core zone, 940 km^2 which is surrounded by a 1,134 km^2 multi-use zone known as the

buffer zone (Appendix 1; Miller et al. 2016b; Negi and Shukla 2012). During the data collection period, 8 villages remained in the interior core zone of the park.

Locals living near KNP may encounter wildlife species when entering the buffer or surrounding areas to collect timber products or graze their livestock. KNP locals depend on timber for subsistence and non-timber forest production collection for profit. Timber forest product collection in the park is particularly prevalent, regardless of legality, as locals use firewood to cook meals and heat their homes. Locals also collect bamboo and use it to create shelters for livestock or crop storage. Other products collected specifically for profit include mahua flowers to create locally-sold wine and tendu leaves to create cigarettes which are dried out and later sold to cigarette producers.

KNP locals own approximately 92,000 head of livestock (Negi and Shukla 2012) and, due to the lack of resources near villages, livestock are grazed in the buffer zone and surrounding areas. Of the variety of wildlife found in KNP, tigers, leopards, and dholes are the most likely to prey upon livestock (Negi and Shukla 2012). Between 300 and 600 livestock are killed by tigers and leopards annually (Miller et al. 2016), with up to 700,000 Indian rupees in compensation paid out toward livestock damage (Negi and Shukla 2012). Predators may also injure or kill humans in KNP; between 7 and 21 people are killed each year, amounting to upwards of 200,000 Indian rupees in compensation paid to victim's families (Negi and Shukla 2012). Due to the presence of predators and persistent conflict, KNP is an ideal study site for HPC research.

Survey Implementation

Our data were collected between February 26 and May 31, 2018. We employed a stratified random sampling method wherein we chose every 5th village from a list of all 161 villages located within 5 kilometers of KNP giving us 55 villages to survey (47 in the buffer and 8 in the core). After administering the in-person questionnaire to these villages, we employed our sampling method again, removing the previously selected villages from the list of villages and instead choosing every 10th village. Our sample frame consisted of a total of 55 villages.

We included 4 females and 4 males from each of the 55 selected villages using a convenience sample. We approached houses with people at home, women in schools, and groups of people in villages for interviews. If the gender of participant we needed was not available, we moved to the next location, being vigilant in spreading out the participants amongst the village when possible. If participants informed us of others in the village who were attacked or surviving members of someone who was killed by a predator, we approached them for inclusion in the study. These individuals that had experienced attack were administered the questionnaire in addition to the 8 people per village.

After gaining consent from participants for their participation in the study, the participants were read the questionnaire in Hindi and their answers were translated into English and recorded by the principle investigator. When participants gave permission, we also audio-recorded the interviews. If permission was denied for audio-recording, the Hindi-English translator also hand recorded responses in Hindi. Each interview with a participant lasted between 20 to 90 minutes.

Questionnaire Design

We collected sociodemographic data from participants that pertained to them individually: age, caste, religion, occupation, and highest level of education completed. We also asked questions pertaining participants' households: the age, gender and occupation of other members of the household, as well as the household's gross total income. To better understand the day-to-day activities of participants' households, we asked questions about the collection of forest products (i.e., if they collected forest products and which products they collected) and livestock ownership (i.e., if they owned livestock and which species of livestock they owned).

In order to test participant's ability to identify predator species in their area, we showed study participants photographs of nine species of predators living in KNP (i.e., tiger [*Panthera tigris*], leopard [*Panthera pardus*], sloth bear [*Melursus ursinus*], hyena [*Hyaena hyaena*], wolf [*Canis lupus*], Indian wild dog/dhole [*Cuon alpinus*], jackal [*Canis aureus*], Bengal/Indian fox [*Vulpes bengalensis*], and jungle cat [*Felis chaus*]). With all nine photographs numbered and visible to participants during the interview, we asked participants to point to the photograph that showed a particular species and recorded their response. We continued this process until the participant had indicated a photograph for all 9 species. We encouraged participants to pick a photograph rather than answer "I don't know." If the participant refused to choose a species, we marked it "IDK."

We assessed attitudes towards tigers and leopards using ten Likert statements from our questionnaire and created an aggregate scale to represent a participant's overall

attitude towards tigers (Table 1) and leopards (Table 2). For one of the ten statements included, we combined two Likert statements from the questionnaire (i.e., the protection of tigers/leopards, and the protection of their habitat by law in India) by using their mean. For this aggregate scale, 10 was the minimum score, which represented the most strongly negative attitudes towards tigers/leopards, 30 was the maximum, which represented strongly positive attitudes towards tigers/leopards.

Table 1. Mean and standard deviation of the individual Likert statements from of attitudes toward **tigers** variables and aggregate scale totals from a questionnaire that was administered to KNP locals from 54 villages (n=400) from Feb–May 2018. All statements are on a 3 pt. Likert scale (1=disagree, 2=neither agree nor disagree, 3= agree).

Statement	**Mean Statement response**	**SD**
Must be scared away, even if they are not causing damage/harm*	1.57	0.90
Tigers and their habitat should be protected by law in India**	2.86	0.46
Ecosystem importance	2.76	0.65
Religious importance	2.46	0.89
Cultural importance	2.71	0.71
Poachers should be punished	2.92	0.39
Despite their protection by law, it is sometimes acceptable to kill tigers*	2.66	0.75
All should be removed from India*	2.56	0.83
All are dangerous*	1.59	0.91
If the number of people in my village increases, attacks will increase*	2.16	0.99
Aggregate Scale (range 10-30):	**24.2**	**3.45**

*Reverse coded
**Combined statement

Table 2. Mean and standard deviation of the individual Likert statements from of attitudes toward **leopards** variables aggregate scale totals from a questionnaire that was administered to KNP locals from 54 villages (n=400) from Feb–May 2018. All statements are on a 3 pt. Likert scale (1=disagree, 2=neither agree nor disagree, 3= agree).

Statement	Mean Statement response	SD
Must be scared away, even if they are not causing damage/harm*	1.64	0.93
Leopards and their habitat should be protected by law in India**	2.86	0.47
Ecosystem importance	2.76	1.62
Religious importance	2.24	0.97
Cultural importance	2.53	0.85
Poachers should be punished	2.91	0.42
Even if they are protected by law, there are times when it is acceptable to kill leopards*	2.65	0.76
All should be removed from India*	2.53	0.85
All are dangerous*	1.64	0.93
If the number of people in my village increases, attacks will increase*	2.24	0.97
Aggregate Scale (range 10-30):	**24.04**	**3.91**

*Reverse coded
**Combined statement

The questionnaire was first designed in English, translated into Hindi with a Hindi-English translator, then back-translated in English from the Hindi-English translator to the researcher. We conducted our pretest of the questionnaire using six local community members to check for translation accuracy and understanding. We received permission to conduct our study from the Madhya Pradesh Forest Department's Principal Chief Conservator of Forests and the Field Director of KNP. Clemson University Institutional Review Board approval was secured before the start of the study (IRB 2018-010).

Data Analysis

We created binary variables to represent the participant's ability to identify each of the predators. Thus, if the participant pointed to the correct photograph for a given

species, we coded their response as a 1, and coded their response as a 0 (zero) if they pointed to any other photograph. Using the 9 binary response variables as dependent variables, we used binary logistic regression to determine the factors influencing participants' ability to correctly identify photographs of predator species. We used 11 sociodemographic variables as our independent variables: whether or not the participant collects FOREST PRODUCTS, whether or not the participant GUARDs their livestock, whether or not the participant has had LIVESTOCK injured or killed by a tiger, whether or not the participant had been INJURED by a tiger, the participant's GENDER, whether or not the participant is a member of the GOND CASTE, whether or not the participant's RELIGION is Gond or Hindu whether or not the participant's primary occupation is FARMING, the participant's total annual household INCOME, whether or not the participant attended SCHOOL, and the participant's AGE (Table 2). We calculated all descriptive and inferential statistics using Statistical Package for Social Sciences (SPSS 2016).

Results

The average participant was male (51%; Table 3), approximately 35 years old[1], a member of the Gond caste (62.7%), and affiliated with either Gond or Hindu religion (93.4%). Most respondents had lived in the village in which they currently live for their entire life (94%), attended school at any level or duration (87.2%), and completed a 5th to

[1] *Most participants indicated they did not know their exact date of birth and that they were approximating their age.*

8th grade-level education (34.6%). The primary occupation of the majority of participants was farming (54.8%); the remaining 45.2% reported their primary occupation as housewife/husband (10.6%), small business owner/manager (9%), laborer (5.3%), tourism (4.6%), teacher (4.2%), student (3.2%), unemployed (1.6%), or other (6.7%). Of the portion of our sample that did not farm as their primary occupation, 17.8% indicated farming was their secondary occupation. It was reported that others in the household also worked as farmers (77.2%) for their primary occupation. The mean household income was 57,870 Indian rupees (approximately US $876.82) per year (Table 3).

The typical participant collected forest products (66%), most often firewood (64.1%), with 70.9% of participants collecting more than one forest product. Other non-timber forest products collected were mahua (32.4%), a flower used to make a local wine, tendu (31.2%), a leaf collected for cigarette production, and other products (4.2%), such as bamboo, used for livestock enclosures. A large majority of participants grew crops (90.4%), predominately rice (99.4%) and wheat (40.1%). Seventy-percent of participants grew more than one crop. Of the 84.5% of participants that owned livestock, 79.9% owned cattle, 19.3% owned buffalo, and 12% owned goats; 39.9% of participants owned more than one species of livestock. Of the participants that owned livestock, 92% of them indicated that they guarded their livestock from predator attack. The typical participant did not have livestock that was injured or killed by a tiger (68.4%) and had not themselves been injured by a tiger (99.3%).

Table 3. Variables used in binary logistic regressions to predict participant's ability to identify each of the 9 predator species from a questionnaire administered to KNP locals from 54 villages (February–May 2018).

Variable	Variable Type	Description	Mean/ %	SD
FOREST PRODUCTS	Binary	0 = does not collect forest products, 1 = collects forest products	65.9%	-
GUARD	Binary	0 = guards their livestock, 1 = does not guard their livestock	92.2%	-
LIVESTOCK	Binary	0 = livestock have not been injured or killed by a tiger, 1 = livestock have been injured or killed by a tiger	31.6%	-
INJURED	Binary	0 = participant has not been injured by a tiger, 1 = participant has been injured by a tiger	0.7%	-
GENDER (male)	Binary	0 = male, 1 = female	51%	-
GOND CASTE	Binary	0 = not in the Gond caste, 1 = in the Gond caste	62.7%	-
RELIGION	Binary	0 = religion is not either Gond or Hindu, 1 = religion is either Gond or Hindu	93.4%	-
FARMING	Binary	0 = primary occupation is not farming, 1 = primary occupation is farming	54.8%	-
INCOME[a]	Continuous	In Indian rupees; Gross total household income level in thousands of Indian rupees (Rs)	57.87	100.74
SCHOOL	Binary	0 = did not attend school, 1 = attended school	87.2%	-
AGE	Continuous	In years	36.53	12.12

[a] Gross total household income level in thousands of Indian rupees (Rs).

The ability to identify the 9 species correctly varied considerably by species, with most participants able to identify the bear (98.6%), while only 24.3% of participants correctly identified the jackal (Table 4). Demographics, livestock ownership and guarding, and past experiences predicted the correct ID of predator species by participants.

Table 4. Mean and standard deviation of the ability to identify each of the 9 predator species from a questionnaire that was administered to KNP locals from 54 villages (n=400) from Feb–May 2018. All responses were binary based on whether the participant correctly identified the predator species (0=incorrect, 1=correct).

Species	Mean
Tiger	89.9%
Leopard	74.4%
Bear	98.6%
Hyena	42.3%
Wolf	24.5%
Dhole	38.9%
Jackal	24.3%
Jungle Cat	45.3%
Fox	20.1%

Regression results

Livestock ownership

All other variables held constant (Table 5), FOREST PRODUCTS showed a weak positive correlation with the correct ID of bears and a weak negative correlation with the correct ID of jungle cats. Participants who collected forest products were more likely to correctly identify bears and less likely to correctly identify jungle cats.

Sociodemographics

Our regressions highlighted a significant result for GENDER (Table 5), wherein GENDER was negatively correlated with the correct ID of leopard, hyena, dhole, and jackal, and had a strong negative correlation with ID of tigers, indicating that males were more likely than females to identify tigers, leopards, hyenas, dholes, and jackals correctly. GOND CASTE was a predictor for the correct ID of hyenas and dholes, and had a strong negative correlation with ID of hyenas. This negative correlation means that members of castes other than Gond were more likely to correctly identify dholes and

hyenas than others. Our results showed that the RELIGION variable had a weakly negative correlation with the correct ID of jackals and a weakly positive correlation with the correct ID of jungle cats. These correlations meant that those who were affiliated with the Gond or Hindu religions correctly identified the jackal more often and the jungle cat less often than others.

The FARMING variable was negatively correlated with the correct ID of dholes; participants who farmed were less likely to correctly identify the dhole than those who did not farm as their primary occupation. The INCOME variable was positively correlated with the correct ID of jackals (Table 5), indicating that participants with higher incomes were more likely to correctly identify jackals than those with lower incomes. Additionally, we found that INCOME was positively correlated with the participant's completed level of education. SCHOOL was positively correlated with a participant's correct ID of the leopard photograph, thus, participants that attended school were able to correctly identify leopards more often than participants that did not attend school.

AGE had a strong negative correlation with the correct ID of both the tiger and the jungle cat, while a slightly weaker relationship was found with AGE and leopard identification. The negative correlation between AGE and the participant's correct ID of tiger, leopard, and jungle cat (Table 5) indicates that younger participants were more likely to be able to correctly identify the tiger, leopard, and jungle cat photograph than older participants.

In addition to correct ID, we also assessed participants' attitudes towards tigers and leopards. According to the mean attitude aggregate scales, attitudes towards tigers

were positive with a mean overall score of 24.2 (range: 10-30; Table 1). Participants' attitudes towards leopards were also positive with a mean overall score of 24.04 (range:10-30; Table 2).

Table 5. Estimated coefficients and standard errors of logistic regression models predicting participant's ability to correctly identify each of the 9 predator species from a questionnaire administered to KNP locals from 54 villages (February–May 2018).

	Estimated coefficients and (standard errors)								
Variable	**Tiger**	**Leopard**	**Bear**	**Hyena**	**Wolf**	**Dhole**	**Jackal**	**Jungle Cat**	**Fox**
FOREST PRODUCTS	0.14 (0.46)	-0.36 (0.33)	1.95* (1.16)	0.34 (0.27)	-0.29 (0.3)	0.15 (0.27)	-0.38 (0.30)	-0.45* (0.27)	-0.36 (0.33)
GUARD	-0.05 (0.65)	-0.70 (0.57)	-16.86 (6595.97)	0.14 (0.44)	-0.14 (0.5)	-0.65 (0.44)	0.17 (0.52)	0.13 (0.43)	0.07 (0.54)
LIVESTOCK	0.35 (0.45)	0.07 (0.3)	-0.55 (1.14)	0.04 (0.25)	0.08 (0.28)	0.1 (0.25)	-0.21 (0.29)	0.17 (0.25)	-0.18 (0.3)
INJURED	-1.24 (1.26)	-1.15 (1.09)	17.98 (17122.63)	0.86 (1.05)	-20.4 (19495.22)	-20.86 (19317.83)	0.05 (1.22)	0.43 (1.06)	-19.85 (200031.21)
GENDER	-1.6*** (0.48)	-1.08*** (0.3)	-17.74 (2619.85)	-0.87*** (0.25)	-0.13 (0.28)	-0.89*** (0.25)	-0.72** (0.29)	-0.31 (0.24)	0.46 (0.31)
GOND CASTE	0.5 (0.41)	0.11 (0.29)	0.55 (1.08)	-0.45* (0.24)	0.39 (0.29)	0.58** (0.25)	0.25 (0.29)	-0.22 (0.24)	0.41 (0.31)
RELIGION	0.48 (0.71)	-0.86 (0.68)	-17.74 (6899.24)	-0.38 (0.48)	0.45 (0.65)	-0.34 (0.5)	-0.9* (0.51)	0.94* (0.52)	-0.37 (0.55)
FARMING	-0.12 (0.44)	-0.05 (0.3)	-1.73 (1.20)	-0.33 (0.26)	0.18 (0.29)	-0.55** (0.26)	0.02 (0.3)	-0.26 (0.25)	-0.21 (0.31)
INCOME[a]	<0.01 (<0.02)	<0.01 (<0.02)	-<0.01 (<0.02)	0.01 (<0.01)	-<0.01 (<0.01)	<0.01 (<0.01)	<0.01** (<0.01)	-<0.01 (<0.01)	-<0.01 (<0.02)
SCHOOL	0.14 (0.5)	0.71** (0.36)	2.03 (1.31)	0.24 (0.36)	0.48 (0.44)	0.03 (0.37)	0.03 (0.43)	0.13 (0.37)	0.57 (0.49)
AGE	-0.04*** (0.02)	-0.03** (0.01)	0.07 (0.07)	0.01 (0.01)	0.01 (0.01)	<0.01 (0.01)	-<0.01 (0.01)	-0.03*** (0.01)	<0.01 (0.01)
Constant	3.90 (1.42)	3.72 (1.12)	51.85 (9897.98)	0.02 (0.87)	-2.43 (1.06)	0.53 (0.85)	-0.2 (0.95)	0.58 (0.87)	-1.72 (1.06)
Nagelkerke R-squared[b]	**0.132**	**0.139**	**0.354**	**0.082**	**0.040**	**0.101**	**0.087**	**0.089**	**0.046**

*P < 0.10, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
**P < 0.05, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
***P < 0.01, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
[a] Gross total household income level in thousands of Indian rupees (Rs).
[b] Cameron and Windmeijer (1997).

Discussion

Overall trends in our results suggest that species that are important for tourism and visually distinct are well known to our participants. Tigers, leopards, and bears are high value tourism species and KNP marketing materials makes their images a common

sight near the park, as such, participants are likely more familiar with them than other predators. Furthermore, tigers, leopards, and bears are all charismatic megafauna and have distinct visual appearances, both in general and from each other, which can help explain why people recognize them. Additionally, bears are the only species in their family (i.e., Ursidae) found in the area, thus nothing else looks remotely similar to them in central India.

Conversely, participants appeared to be less familiar with species that are rarely sighted, less visually distinct, and not as valued for tourism. Participants were half as likely to correctly ID smaller predators which can be attributed to their elusive or nocturnal nature. Aside from size, wolves, dholes, jackals, jungle cats, and foxes all may look generally similar to the untrained eye. Thus, in order to fill this familiarity gap, education efforts, existing and future, could focus on teaching the identification and behaviors of lesser-known species. Such efforts may be framed as advantageous to locals for use in the tourism industry as well as important to maintaining local culture through learning about the wildlife in their area. The Forest Department has already implemented the "Kanha Bhoorsingh Playschool," which teaches school children about wildlife found in KNP (Dixit 2018). In addition to school children, educational programs that involve all ages could be implemented to increase familiarity with all predator species in KNP.

Those who collect forest products in the buffer zone of KNP being more likely to identify the bear and less likely to identify the jungle cat correctly may be due to the distinctness of these species. Visually, bears are distinct from other species, while jungle cats look similar to other species included in the interview, such as jackals, dholes, and

foxes. Even though those that collect forest products are likely to encounter wildlife species while collecting (Ogra 2008), they do not receive any formal training to be able to tell non-distinct species apart.

Our result that males are better able to identify predator species than females may be related to gender roles within the community. Tasks viewed as male responsibilities include guarding crops and livestock, reporting compensation, and participating in ecodevelopment committees, while female responsibilities include household tasks, caring for children and elders, planting crops, and forest product collection (Ogra 2009). Thus, males correctly identifying the tiger, leopard, hyena, dhole, and jackal more than females may be due to the need to recognize potentially dangerous species during traditionally male tasks. However, while dhole packs may venture into the buffer zones, they often stick to the meadow areas of KNP (Negi and Shukla 2012), thus those that farm as their primary occupation would not see dholes when tending to their crops in the buffer or surrounding areas and would be less likely to identify them than others.

Members of the Gond caste have historically tended to and cared for livestock (Negi and Shukla 2012), thus, are more likely to come across wildlife species which may explain why those in the Gond caste were able to ID dholes than others. Members of the Gond caste being less likely to identify hyenas than others is likely due to the high population of Gonds around KNP. Hyenas are extremely rare in KNP and it is likely that only those who have received wildlife identification training would be able to correctly identify them. Similarly, our result showing that participants were less likely to identify jackals and more likely to identify the jungle cat if their religion is either Gond or Hindu

can be explained by the sheer number Gonds and Hindus that live in and around KNP. In KNP, villages are segregated by castes, with groups of similar castes living in small communities within the village. There is likely a spatial variable that we did not consider in our research that could be included in future research to better explain these findings.

The tendency of dholes to remain in the meadows of the core area of KNP (Negi and Shukla 2012), may explain our finding that those who farmed as their primary occupation being less likely to identify dholes than others. Herzon and Mikk (2007) found that while farmers were interested in learning about wildlife, they mostly concerned themselves with species that were useful or harmful to farming. Therefore, with dholes primarily residing within the core area of KNP, farmers do not concern themselves with the identification of dholes.

The future opportunities that attending school provides relative to wildlife, such securing a tourism-related jobs at lodges, tour companies, or KNP itself, may help explain our result that participants who received formal education were able to ID predators more than those that had not attended school; formal education allows people to receive more opportunities that allow for exposure to information about wildlife, while literacy allows people to learn about wildlife from printed media (Nyhus et al. 2003). Relatedly, our finding that participants with higher incomes identified the jackal more often than others can be explained by the correlation between income and the highest level of education completed, as more formal education can lead to increased comfortability and conversational skills with formal language (Nyhus et al. 2003). As illiteracy is a common a problem in forest-dependent communities globally, educational

programs would benefit from the implementation of oral presentations in local languages to ensure wildlife knowledge is accessible to everyone. Additionally, it is crucial to support expanding the reach of programs that work to improve literacy and ability to identify wildlife in local communities so that more people are able to use current education materials.

Our result that younger participants were more likely to correctly identify predators than others may be due to the responsibility of younger people to perform outdoor activities, such as forest product collection. This is in line with Nyhus et al. (2003), who indicate that a higher level of knowledge in younger people is due to young adults collecting forest products, hunting, and performing other outdoor activities. Thus, younger participants had more potential exposure to wildlife which explains our result that younger participants correctly identified tiger, leopard, and jungle cat photographs more than older participants. An increased knowledge of wildlife has been shown to decrease fear of wildlife, increase tolerance of HWC, and improve attitudes towards wildlife (Lagendijik and Gusset 2008). Thus, is it important to create educational programs for KNP locals to learn wildlife species identification and important information about wildlife. KNP has already begun this process with "Kanha Bhoorsingh Playschool". Expanding the content and reach of the program to include more species and more age groups of participants would improve the general knowledge, and accordingly the tolerance of, wildlife in KNP.

The repercussions of the scientific community publishing literature that does not have checks and balances in place for confirming the correct ID of conflict species are

significant. While the majority of participants were able to identify tigers, leopards, and bears, there were many who were not able to identify these species. Therefore, it is important that future researchers avoid the assumption that everyone can ID and instead include methods to test identification ability. Without identification measures, incorrectly blaming a species for HWC may lead to negative attitudes toward the species, as well as unsuccessful management plans and mitigation efforts. Since we found that that attitudes towards tigers and leopards were moderately high in KNP despite conflict, and the repercussions of inaccurate blame have been found to be significant in other studies, it is important that future HWC research in KNP includes methods to test identification ability among participants.

In addition to the main discussion points from our study (i.e., to include methods for correct ID and to expand upon and create wildlife education programs) that can be applied to research on any species involved or implicated in conflict in any location around the world, we also feel that best study practices should include using neutral language when discussing potential conflict species. The avoidance of labeling wildlife as a "conflict species" during research is important to prevent potentially biased findings.

APPENDICES

Appendix 2

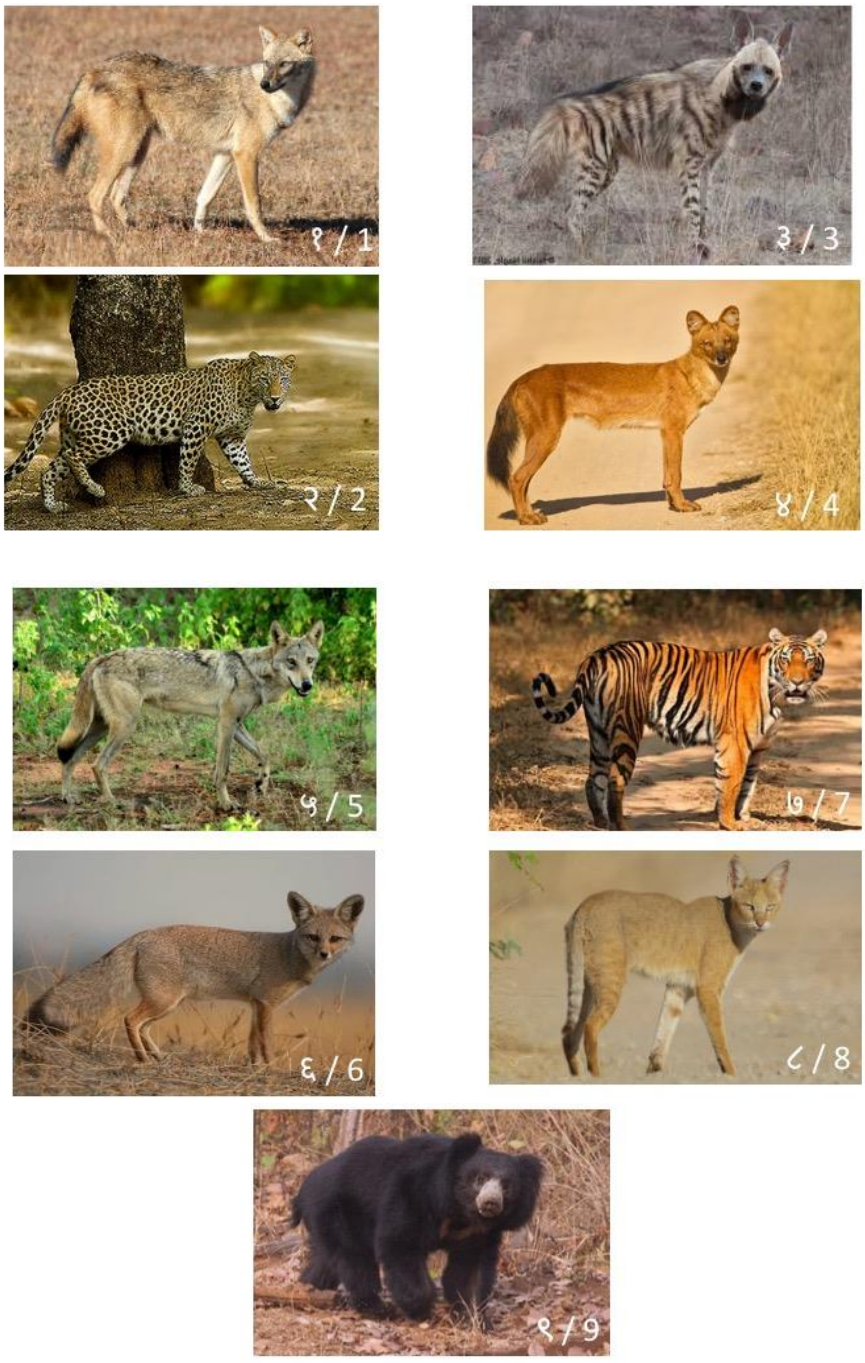

Figure 2.1 Photographs of the 9 predator species found in KNP that were used to test the identification ability of participants.

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CHAPTER TWO

ASSESSING THE DIRECT AND INDIRECT IMPACTS OF HUMAN-TIGER CONFLICT IN KANHA NATIONAL PARK, INDIA

Introduction

Declines in habitat for predators can lead to an increase in contact between predators and humans; as contact increases, conflict between humans and predators is likely to also increase (DeMotts and Hoon 2012). Human-predator conflict (HPC) can be challenging for efforts that aim to conserve predators, as it may reduce local support for conservation. Reductions in local support can threaten not only predator populations (Ripple et al. 2014; Burton et al. 2011; Agarwala et al. 2010; Ogra 2008; Rodriguez 2008; Ogada et al. 2003), but may also threaten community development by limiting social and household activities and employment and means for subsistence livelihood opportunities in communities due to the proximity of predators and local's fear associated with predators' proximity (Mayberry et al. 2017; Barua et al. 2012; Ogra 2008).

HPC tends to be concentrated in areas that surround protected areas (Miller et al. 2016a; Ogra 2009; Chowdhury et al. 2008; Nyhus and Tilson 2004; Woodroffe and Ginsberg 1998; Newmark et al. 1994) and can be particularly prevalent in areas where large populations of predators and people cohabitate (Inskip and Zimmerman 2009; Woodroffe et al. 2005). People living near predators are often dependent on protected areas for subsistence collection and use of natural resources that occur in them (e.g.,

forest products, livestock grazing; Mukherjee 2011; Khan et al. 2008; Adhikari et al. 2004; Masozera and Alavalapati 2004), while predators commonly leave protected areas and enter surrounding communities in search of food, water, and territory (Barua et al. 2012; Inskip and Zimmermann, 2009; Ogra 2009; Miquelle et al. 2005). With both predators and local people frequently traveling between protected areas and surrounding human-dominated areas, the resulting HPC can have direct impacts on locals in the form of injury or death of humans or livestock (Miller et al. 2016b; Karanth et al. 2013; Dickman 2010; Ogada et al. 2003) and physical damage to other property (e.g., guard dogs; Rust et al. 2013). These direct impacts increase the likelihood for retaliatory killings of predators that have attacked livestock and people (Acha et al. 2017; Negi and Shukla 2012; Rastogi et al. 2012; Dickman 2010; Kissui 2008; Rodriguez 2008).

While the direct impacts of HPC on sympatric human populations are well-known and studies are abundant in literature (e.g., Miller et al. 2016b; Karanth et al. 2013; Dickman 2010; Ogada et al. 2003), conflict with wildlife can result in a suite of less obvious indirect impacts that are infrequently studied, yet may have more pervasive and long-lasting effect on people as compared to direct impacts (Hunter et al. 1990). These indirect impacts have also been referred to as hidden impacts (Bond and Mkutu 2018; Mayberry et al. 2017; Khumalo and Yung 2015; Barua et al. 2012; Ogra 2008), secondary impacts (Hunter et al. 1990), ecosystem disservices (Ango et al. 2016), and intangible costs (Kansky and Knight 2014), and include impacts such as fear, stress, sleep deprivation, increased disease vulnerability, family dynamics, and time/effort of pursuing compensation (e.g., Bond and Mkutu 2018; Silwal et al. 2016; Soulsbury and White

2016; Kansky and Knight 2014; Barua et al. 2012; Hill 2010). Previous studies that have uncovered indirect impacts of human-wildlife conflict (HWC), either set out to assess direct impacts or were small sample case studies. Further, even fewer of these studies have thus far focused on conflict with predators. Therefore, it is not possible to gain sufficient background on indirect impacts for our predator conflict study without drawing on the limited selection of literature related to the indirect impacts of conflict with wildlife, in general.

The available research related to the indirect impacts of conflict can be separated into several themes of indirect impacts (Figure 1), including physical health impacts (e.g., disease), mental health impacts (e.g., PTSD, Depression), shifting family dynamics, and social issues (i.e., gender disparity and stigmas). The impact of HWC on physical health is most evident in those who guard livestock or crops against wildlife attack and those who collect items from the forest for subsistence or commercial gain (henceforth referred to as forest products; Soulsbury and White 2016; Barua et al. 2012; Dutta et al. 2010). Zoonotic and vector-borne diseases impact locals who frequent, or live in, areas surrounding protected areas, as they spread in areas which are shared by wildlife and livestock (Soulsbury and White 2016; Barua et al. 2012; Dutta et al. 2010). Locals are especially at risk of contracting disease if they are guarding at night (Barua et al. 2012; Dutta et al. 2010; Hill 2010). In addition to increased risk of disease, those guarding livestock or crops may also face sleep deprivation from their need to remain vigilant for hours at a time (Khumalo and Yung 2015; Barua et al. 2012). Those who have lost cattle to predators, and therefore a portion of their livelihood, may have nightmares which may

impact their quality of sleep (Bond and Mkutu 2018). Despite the literature's focus on the negative indirect impacts, HWC may also provide indirect benefits to physical health as well. As shown in Mumbai, India, Braczkowski et al. (2018) found that leopards preying on stray dogs actually benefitted the nearby community through the reduction of dog attacks, rabies transmission, and money and resources to control the stray dog population. Additionally, there may be an increase in wildlife species' populations as they were facing less depredation by stray dogs (Braczkowski et al. 2018).

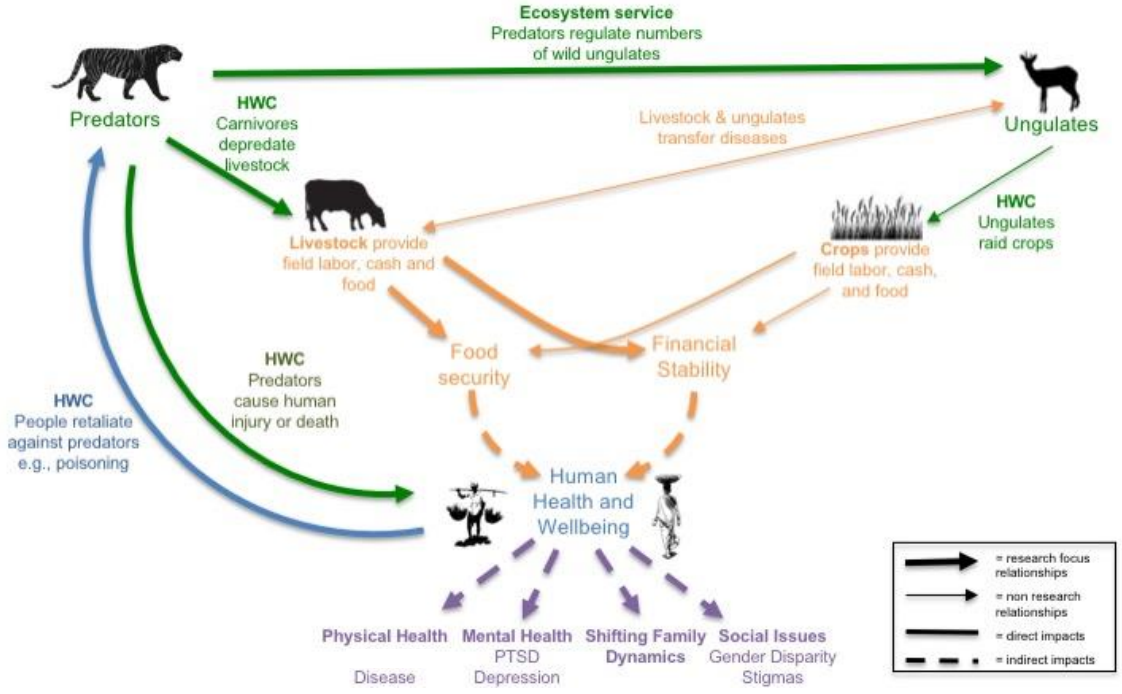

Figure 1. Potential direct and indirect impacts experienced from HWC are represented this "Web of Wildlife Conflict Impacts." In this figure, bold arrows represent our focal impacts, whereas thin arrows represent auxiliary impacts of HWC.

An often looked-over and stigmatized impact of HPC is mental health, which is reported in literature to be especially present following traumatic events such as human or livestock loss. In an assessment of mental health impacts on those affected by predator

attacks, Chowdhury et al. (2008) interviewed tiger and crocodile attack survivors and widows of tiger attack victims, with the majority of the attacks occurring in the last 5 years. They found mental health issues related to the attack in survivors, including Post Traumatic Stress Disorder (PTSD), alcohol dependence, Major Depressive Disorder, Somatoform Pain Disorder, Adjustment Disorder, and deliberate self-harm attempts (Chowdhury et al. 2008). Similar studies evaluated the potential impacts of wildlife attack on families and surviving victims, and found that survivors of attack may experience negative impacts such as PTSD, clinical depression (Barua et al. 2012; Jadhav and Barua 2012; Jadhav 2011; Chowdhury et al. 2008), childhood emotional disorder, and lowered childhood development (Barua et al. 2012; Jadhav and Barua 2012; Jadhav 2011).

Additional indirect impacts of HWC may have downstream impacts on locals. If locals living near wildlife guard their livestock or crops at night, they may also become sleep deprived. While, sleep deprivation immediately impacts physical health, it may also impact the mental health of an individual (Barua et al. 2012). Those living near predators may also experience heightened fear and stress following an attack (Bond and Mkutu 2018; Mayberry et al. 2017; Chowdhury et al. 2016; Khumalo and Yung 2015; Barua et al. 2012; Chowdhury et al. 2008), which can further impact mental health. One study suggested that just living in close proximity to predators can incite fear and stress (Braczkowski et al. 2018), which can lead to future health issues. Further, Bond and Mkutu (2018) found that loss from livestock depredation can lower the self-esteem of locals, as the majority of the cultural capital and habitus in these communities is based

upon livestock ownership. Losses from conflict may be compounded by institutional gaps (e.g., insecure property rights and loss of access to traditional resources) that locals face (Bond and Mkutu 2018).

The responsibilities within and functioning of a family may be negatively impacted following a wildlife attack on a member of the family. Silwal et al. (2016) interviewed people living near Chitwan National Park in Nepal about human injuries related to wildlife attacks (i.e., tiger, rhino, elephant, sloth bear, and wild boar); their research indicated that if the victim survived the attack, the victim frequently became a burden on other family members due to the cost of treatment and care of their wildlife-related injury. Another study in Assam, India focusing on the impacts of human-elephant conflict found that the ramifications of wildlife attacks on humans included shifting household dynamics (Jadhav and Barua 2012). When such household dynamic shifts occur, the additional responsibilities that the victim can no longer perform can weigh heavily upon other members of the household, depending on which member of the household is the victim and the severity of their injuries. For instance, when the head of the household is attacked or killed, the victim's financial responsibilities are likely to fall upon the victim's spouse and/or eldest child who then might have to find additional paid work while also carrying out household activities (Chowdhury et al. 2016; Barua et al. 2012; Jadhav and Barua 2012). Additionally, Chowdhury et al. (2016) found that following a death by tiger, the surviving members of the family often had to move, whether it be to another family member's household, into a neighborhood designated for

widows, or out of the village completely due to the overwhelming stigmatization of the traumatic events that occurred.

Literature on HWC suggests that conflict, and indirect impacts specifically, may disproportionately impact women in comparison to men (Chowdhury et al. 2016; Ogra 2009; Ogra 2008). In a study of impacts of HWC on villagers in Uttarakhand, India, Ogra (2008) found women who are dependent on forested areas were more vulnerable to the indirect impacts of HWC as compared to men, who bore more of the direct impacts. Women have been found to bear more of the burden after an attack as they may be expected to make sacrifices for the well-being of the family, sometimes in the form of overwhelming workloads and reduced food resources (Chowdhury et al. 2016; Ogra 2009; Ogra 2008). Women's added responsibilities and reduced resources may lead to decreased physical and mental well-being (Barua et al. 2012; Jadhav and Barua 2012; Ogra 2009).

Researchers have found that social stigmas may be yet another indirect impact of HWC that negatively impacts locals. When a tiger attack occurs on a member of a family, the family may become stigmatized by their community as "cursed" (Chowdhury et al. 2016). Chowdhury et al. (2016, 2008) found that widows of husbands who have been killed by tigers were subject to cultural rules for tiger widows; these rules included being forced out of their homes and into communities for tiger widows, banned from participating any religious ceremonies or prayers as they are "unholy", and required to wear white saris instead of colorful saris (Chowdhury et al. 2016). This stigma could be compounded if the husband's death occurred shortly after marriage as there is a

widespread cultural belief that a sudden death of a husband is due to a wife's disobedience (Chowdhury et al. 2008). These stigmas may disproportionately affect women in India where 10% of the female population are widows and where patriarchy still dominates the social and cultural identity of women (Chowdhury et al. 2016). Conversely, Chowdhury et al. (2016) found that widowers were not subject to the social stigma or cultural rules that widows faced. School-aged children whose fathers were killed by a tiger were also subject to stigma (Chowdhury et al. 2016; Silwal et al. 2016). In such cases, the stigma manifested as teasing from other children which caused some of the victim's children to drop out of school (Chowdhury et al. 2016; Silwal et al. 2016); those who did not drop out from teasing were likely to eventually drop out in lieu of work to contribute to the family's finances (Chowdhury et al. 2016). Social issues revolving around HPC, such as gender disparity and stigmas, can increase potential for negative attitudes towards predators by those impacted (Silwal et al. 2016) and can lead to further impacts on an individual's health (Barua et al. 2012).

To augment the limited literature on the indirect impacts of HWC and HPC specifically, we conducted a study of locals living in and around Kanha National Park (KNP), in Madhya Pradesh, India. The limited literature related the indirect impacts of HWC, and the negative impacts of conflict necessitates additional research to gain a better understanding of indirect impacts, especially in areas where predators and people coexist. India was chosen for this study as the majority of protected areas in India are surrounded by high levels of human density (i.e., more than three million people; Chowdhury et al. 2008). Additionally, India maintains the largest wild tiger population in

the world along with the second largest human population in the world, therefore the potential for human-tiger conflict (HTC) is immense. Further, KNP experiences the highest rate of depredation of livestock by tigers and leopards in India, and HPC is particularly elevated near the park (Miller et al. 2016b; Karanth et al. 2013). Our research objectives were to: 1) assess if and how people living near KNP have been directly impacted by HTC (i.e., injury or death of humans or livestock, physical damage), 2) assess if and how the lives of people living near KNP have been indirectly impacted by HTC (e.g., psychological impacts, opportunity costs), 3) determine people living near KNP's level of knowledge of tigers and 4) determine people living near KNP's attitudes towards tigers.

Methods

Study Area

KNP was one of nine tiger reserves created to preserve critical tiger habitat during the launch of Project Tiger in 1973. KNP (22.3345° N, 80.6115° E) is the largest national park in Madhya Pradesh and is home to an estimated 89 tigers and 120,000 people living in KNP and surrounding areas (Negi and Shukla 2012). The 2,074 km^2 total protected area of KNP consists of a 940 km^2 limited use, interior core zone, surrounded by a 1,134 km^2 multi-use zone known as the buffer zone (Appendix 1; Miller et al. 2016b; Negi and Shukla 2012). With the exception of park guards who live in forest camps, only 8 villages remain in the interior core zone of the park; all other villages have been relocated from

within the core. Over 120,000 people live within in the buffer zone of the park, some of whom belong to villages that were once located in the core (Negi and Shukla 2012).

KNP locals use the buffer zone and areas outside of the park for the purposes of forest product collection, regardless of legality. The most commonly collected forest item is firewood. Locals use firewood to cook meals and heat their homes, and, as such, some may access forests multiple times a week ensure an adequate supply of this wood for their household. Locals also collect certain forest products for economic purposes, such as mahua flowers to create wine, which is sold locally, and tendu leaves to create cigarettes, which are purchased by a cigarette manufacturer. Many locals also collect bamboo to create fences and structures. Locals owning livestock use the buffer zone and areas outside the park for livestock grazing, as much of the land in and around villages has been converted to cropland and lacks the resources necessary to feed the large amount of livestock reared in villages.

Locals who enter the buffer and surrounding areas for forest product collection or livestock grazing may experience conflict with tigers (Negi and Shukla 2012). Especially, given that livestock are plentiful near KNP (~92,000 head of livestock; Negi and Shukla 2012), and likely easier to take than wild prey, it is not surprising that tigers prey on livestock (as shown in studies: Chowdhury et al. 2016; Miller et al. 2016a; Karanth et al. 2012) causing financial loss for livestock owners. In addition to the risk of livestock depredation by tiger (Miller et al. 2016b; Karanth et al. 2012), livestock guards and those who collect forest products often risk attack by tiger (Miller et al. 2016a; Karanth et al.

2012). This study area allowed us to focus on people with a high risk for tiger conflict due to proximity to and dependency on KNP.

We conducted our research in line with the recommendations of previous research in KNP, which call for an in-depth inquiry into the impacts of HPC on locals (Karanth et al. 2012; Miller et al. 2016b). Focusing on indirect impacts is particularly important as previous studies have not given attention to indirect impacts in KNP specifically, that we are aware of.

Survey Implementation

The questionnaire was administered in person to selected participants living in 55 villages in the KNP buffer (47 villages) and core (8 villages) between February 26 and May 31, 2018. Using a list of 161 villages that exist in the buffer zone and within 5 km of KNP, we used a stratified random sampling method wherein we chose every 5th village for inclusion in our initial sample frame. We included all 8 villages that occur within the park's core in our sample frame as the locals inhabiting these villages live and farm in protected, limited human-influence habitat which is heavily managed for the survival of tigers. Once the sampling for these 39 villages was complete, we drew another sample from the remaining villages on the original list of 161 villages, choosing every 10th village for this second round of stratified random sampling. In total, 55 villages were selected as our sample frame.

Within each selected village, we interviewed 4 males and 4 females. We used a convenience sample to recruit participants within the 54 selected villages. We approached

homes where people were present and homes that had the gender of participant we sought. We also approached people in their place of work (e.g., women in schools) and groups of people in villages for interviews. We were careful to approach participants from different areas of the villages. In addition to choosing participants using convenience sampling, we also approached individuals who had been attacked by a tiger for inclusion in the study. If the person who had been attacked was deceased, we approached a member of their surviving family.

Once participants consented to participate in the study, the questionnaire was read to the participant orally in Hindi and responses were translated to the principal investigator by a Hindi-English translator. The principal investigator recorded the translated responses. When participants gave permission to do so, responses were audio recorded. If permission was not given for audio recording, both the principal investigator and the Hindi-English translator recorded responses in writing during the interview. Interviews lasted between 20 to 90 minutes.

Questionnaire Design

We collected individual sociodemographic information from participants, including age, caste, religion, whether they attended school (at any level), and the highest level of education completed. We also asked about household demographic information including age, gender, occupation of all household members, and gross total household income level. We inquired about household practices of collecting forest products (e.g., products collected, frequency of collection, time spent collecting), agricultural farming

(e.g., species of crop grown, acres farmed, season the crop is cultivated), and livestock ownership and husbandry (e.g., species of livestock, number of each species, grazing practices).

We created 3 aggregate scales to further evaluate knowledge of tigers, attitudes towards tigers, and indirect impacts sustained due to tigers (henceforth referred to as "aggregate scales"). Similar to methods used in Rodriguez et al. (2018), for each aggregate scale, we chose Likert scale statements that addressed different facets of each aggregate scale issue (i.e., knowledge, attitudes, and indirect impacts). For the aggregate knowledge of tigers scale, we chose eight Likert statements regarding participant's knowledge of tigers; one of the eight variables in the knowledge aggregate scale was composed of the mean of two Likert statements (i.e., "Tigers will always attack people", and "…livestock"), while the other seven were individual Likert statements (i.e., individual's perception of their knowledge, dietary habits, social behavior, and conservation status of tigers, frequency of attacks, and how to avoid attacks). The response range of the scores for the aggregate knowledge scale was 8 (minimum), representing a negligible level of knowledge about tigers, to 24 (maximum), representing high level of knowledge of tigers.

To evaluate the aggregate attitudes towards tigers, we chose ten Likert statements regarding participant's attitudes towards tigers; one of the ten was composed of the mean of two Likert statements (i.e., protection of tigers, and protection of their habitat by law in India) while the other nine were individual Likert statements (i.e., removal of tigers, conservation and protection of tigers, significance of tigers to the ecosystem, religion,

and culture, poaching or killing of tigers, and if tigers are dangerous). The response range of the scores for the aggregate attitude scale was 10 (minimum), representing negative attitudes towards tigers, to 30 (maximum), representing positive attitudes towards tigers.

In order to increase our understanding of HTC in KNP, we inquired about both direct and indirect impacts of HTC. To assess direct impacts of HTC, we asked about the frequency and severity of livestock depredation that participants experienced, their perceived risk of such depredation, and if they had ever been injured by a tiger. For the aggregate indirect impacts scale, we chose eleven Likert statements regarding indirect impacts of conflict with tigers; one of the eleven was composed of the mean of two Likert statements (i.e., "I am afraid a tiger will physically injure me" and "…my family") while the other ten were individual Likert statements (i.e., traveling, daily activities, time for work, their personal health, impact on children, personal and family safety, village bonding, benefits). The range of scores for the aggregate indirect impacts scale was 11 (minimum), representing negligible indirect impacts experienced from tiger conflict, to 33 (maximum), representing a high amount of indirect impacts experienced.

For each of the three knowledge, attitude, and indirect impact aggregate scales, we summed the participant's responses to the statements in Microsoft Excel (Microsoft 2018) to get a total score for each individual participant. Statements that were framed opposite (i.e., negatively or positively) to the majority of the other statements included in the aggregate scale were reverse coded so that all statement coding matched in the same statement framing direction. Participants who did not respond within the provided answer

options for any of the Likert scale statements included in the respective aggregate scales were removed from that analysis.

The study questionnaire was designed in English, translated into Hindi, and back-translated into English to check for accuracy. We pretested the questionnaire with 6 staff members from a lodge local to KNP. Permission to conduct research was obtained from the Madhya Pradesh Forest Department's Principal Chief Conservator of Forests and the Field Director of KNP. Our research design, sampling, and data collection procedures were approved by Clemson University Institutional Review Board prior to the start of data collection (IRB 2018-010).

Data Analysis

We calculated the mean and standard deviation for all of the individual statements included in the aggregate scales as well as for the knowledge (Table 1), attitude (Table 2), and indirect impacts (Table 3) aggregate scales. To determine if our selection of variables for the aggregate scales was reliable and distinctly different, we first verified low correlation for the individual Likert statements included in each of the aggregate scales.

Table 1. Mean and standard deviation of individual Likert statements and a **knowledge** aggregate scale used to measure participants' overall knowledge of tigers; from a questionnaire administered to KNP locals from 54 villages (n=400) from Feb–May 2018. All statements are on a 3 pt. Likert scale (1=disagree, 2=neither agree nor disagree, 3= agree).

Actual Statement	Mean Statement response	SD
Knowledgeable of tiger behavior	1.63	0.93
Tigers kill other animals to eat the meat	2.89	0.46
Tigers live in packs*	2.52	0.81
When possible, tigers will always attack people and livestock**	1.68	0.85
Tigers have lost habitat due to human activities	2.59	0.98
Tigers are endangered in India	2.19	0.53
Tigers are legally protected in India	2.85	0.99
Know how to act around tigers to avoid attack	2.13	0.77
Aggregate Scale (8-24 max.):	**18.6**	**2.78**

*Reverse coded

**Combined statement

Table 2. Mean and standard deviation of individual Likert statements and an **attitude** aggregate scale used to measure participants' attitude towards tigers; from a questionnaire that was administered to KNP locals from 54 villages (n=400) from Feb–May 2018. All statements are on a 3 pt. Likert scale (1=disagree, 2=neither agree nor disagree, 3= agree).

Actual Statement	Mean Statement response	SD
Tigers must be scared away, even if they are not causing damage/harm*	1.57	0.90
Tigers and their habitat should be protected by law in India**	2.86	0.46
Tigers are important to the ecosystem	2.76	0.65
Tigers are important for religious reasons	2.46	0.89
Tigers are important for India's culture	2.71	0.71
People who poach tigers should be punished	2.92	0.39
Even if they are protected by law, there are times when it is acceptable to kill tigers*	2.66	0.75
All tigers should be removed from India*	2.56	0.83
All tigers are dangerous*	1.59	0.91
If the number of people in my village increases, tiger attacks will increase*	2.16	0.99
Aggregate Scale (range 10-30):	**24.2**	**3.45**

*Reverse coded

**Combined statement

Table 3. Mean and standard deviation of individual Likert statements and an **indirect impacts** aggregate scale used to measure the indirect impacts of HTC on participants; from a questionnaire that was administered to KNP locals from 54 villages (n=400) from Feb–May 2018. All statements are on a 3 pt. Likert scale (1=disagree, 2=neither agree nor disagree, 3= agree).

Actual Statement	**Mean Statement response**	**SD**
Tiger near my village keeps me from traveling	2.30	0.96
Potential tiger attack prevents me from accomplishing daily chores/activities	1.94	1.0
Child/ren are unable to attend school when a tiger is near	1.59	0.92
My children are afraid of encountering a tiger	2.20	0.98
Livestock guarding takes time away from my primary job	2.21	0.98
Livestock guarding prevents me from getting enough sleep	2.47	0.88
Livestock guarding makes me more susceptible to illnesses	2.6	0.80
Livestock guarding with my neighbors improves social bonds*	1.05	0.32
I worry for my family's physical safety if a tiger enters the village while I am away livestock guarding	2.9	0.44
My family and I benefit from tiger conservation*	1.57	0.90
I am afraid a tiger will physically injure me or my family**	2.67	0.67
Aggregate Scale (range 11-33):	**23.7**	**3.95**

*Reverse coded
**Combined statement

We assessed the factors that influence knowledge, attitudes, and indirect impacts from tigers using multiple linear regression. We chose 11 independent variables for our regressions: collects FOREST PRODUCTS, GUARDS their LIVESTOCK, LIVESTOCK have been ATTACKED by a tiger or leopard, GENDER, member of the GOND CASTE, affiliated with Gond or Hindu RELIGION, primary occupation is FARMING, annual household INCOME, attended SCHOOL (at any level), and AGE (Table 4).

Table 4. Variables used as predictors in linear regression to predict knowledge, attitude, and indirect aggregate scores from a questionnaire administered to KNP locals from 54 villages (Feb–May 2018).

Variable	Variable Type	Description	Mean/%	SD
FOREST PRODUCTS	Binary	0 = does not collect forest products, 1 = collects forest products	65.9%	-
GUARDS LIVESTOCK	Binary	0 = guards their livestock, 1 = does not guard their livestock	87.9%	-
LIVESTOCK ATTACKED	Binary	0 = livestock have not been injured or killed by a tiger, 1 = livestock have been injured or killed by a tiger	31.6%	-
GENDER (male)	Binary	0 = male, 1 = female	50.9%	-
GOND CASTE	Binary	0 = not in the Gond caste, 1 = in the Gond caste	62.6%	-
RELIGION	Binary	0 = religion is not either Gond or Hindu, 1 = religion is either Gond or Hindu	93.2%	-
FARMING	Binary	0 = primary occupation is not farming, 1 = primary occupation is farming	54.8%	-
INCOME[a]	Continuous	In Indian rupees	57.87	100.74
SCHOOL	Binary	0 = did not attend school, 1 = attended school	86.8%	-
AGE	Continuous	In years	36.53	12.12

[a] Gross total household income level in thousands of Indian rupees (Rs).

Results

Our typical participant was 35 years old, male (50.9%), in the Gond caste (62.6%), lived the same village for their entire life (94%), and was affiliated with either Gond or Hindu religion (93.2%). Of the 86.8% of participants that attended school (at any level), 34.6% had completed 5th to 8th grade education level. Primary occupations were farming (54.8%), laborer (5.3%), hotel (0.2%), housewife/husband (10.6%), teacher (4.1%), park (4.4%), unemployed (1.6%), or other (18.6%). Of those that indicated that they had a primary occupation other than farming (45.1%), and that had a secondary occupation (39.1%), it was most frequently farming (17.8%). Others in the household also farmed as their primary occupation (77.2%). The median household income was 59,086.25 Indian rupees per year (~US $856.32). Most participants collected forest

products (66%), of which firewood was the most common (64.1%), followed by mahua (32.4%), tendu (31.2%), and other (4.2%). The majority of participants grew crops (90.4%) as 99.4% of those grew rice and 40.1% of those grew wheat; 70% of participants grew more than one crop. Of the 84.5% of participants that owned livestock, the majority owned cattle (79.9%), while 19.3% owned buffalo, and 12% owned goats; 39.9% of participants owned more than one species of livestock. Eighty-eight percent of participants indicated that they guarded their livestock.

Approximately 60% of participants expressed the belief that the prevalence of tiger attack is high, despite only 19.9% of them having knowledge of a tiger attack on a human within the region and 0.9% being attacked themselves. Of participants who owned livestock, 90.9% believed that their livestock were at risk for tiger attack. However, only 31.6% indicated that their livestock had ever been attacked by a tiger.

The mean score for the knowledge aggregate scale was 18.63 (SD= 2.78; possible range= 8-24; actual range= 8-24), indicating that participants had a moderate level of knowledge of tigers (Table 1). GUARDS LIVESTOCK, GENDER, GOND CASTE, FARMING, and AGE were all predictors of knowledge (Table 5). GENDER and FARMING were strongly negatively correlated, and GOND CASTE had a weak negative correlation with tiger knowledge. These results indicated that males, those in a caste other than the Gond caste, and those with a primary occupation other than farming were likely to have a higher level of knowledge of tigers than others. Two variables were positively correlated with knowledge, GUARDS LIVESTOCK (strongly positive) and AGE

(weakly positive); participants who guarded their livestock and older participants had a higher level of knowledge about tigers than others.

Table 5. Estimated coefficients, standardized coefficients, and standard errors of a model predicting participant's overall **knowledge** of tigers from a questionnaire administered to KNP locals from 54 villages (Feb–May 2018).

Variable	Coeff.	Standardized Coeff.	SE
Constant	18.61	-	1.13
Collects FOREST PRODUCTS	-0.69	-0.12	0.36
GUARDS their LIVESTOCK	1.29***	0.14	0.49
LIVESTOCK have been ATTACKED by a tiger	-0.17	0.03	0.31
GENDER	-1.77***	-0.32	0.32
GOND CASTE	-0.61*	-0.11	0.31
Gond or Hindu RELIGION	-0.10	-0.01	0.68
Primary occupation is FARMING	-0.91***	-0.16	0.32
INCOME[a]	3.284E-5	0.00	0.00
Attended SCHOOL	-0.00	-0.00	0.47
AGE	0.03*	0.14	0.01
R^2= 0.207			

*P < 0.10, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
**P < 0.05, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
***P < 0.01, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
[a] Gross total household income level in thousands of Indian rupees (Rs).

The mean attitude scale score was 24.2 (SD= 3.45; possible range= 10-30; actual range= 10-30), indicating moderately positive attitudes toward tigers (Table 2). The variables GENDER, GOND CASTE, and SCHOOL were all predictors of attitude (Table 6). GENDER and GOND CASTE were negatively correlated with attitude, with GOND CASTE having a strong negative correlation. SCHOOL had a strongly positive correlation with attitude. These correlations indicated that males, participants not in the

Gond caste, and those who attended school all had a more positive attitude towards tigers than others.

Table 6. Estimated coefficients, standardized coefficients, and standard errors of a model predicting participant's overall **attitudes** towards tigers from a questionnaire administered to KNP locals from 54 villages (Feb–May 2018).

Variable	Coeff.	Standardized Coeff.	SE
Constant	21.49	-	1.39
Collects FOREST PRODUCTS	-0.436	-0.06	0.45
GUARDS their LIVESTOCK	0.84	0.08	0.59
LIVESTOCK have been ATTACKED by a tiger	-0.36	-0.05	0.4
GENDER	-0.80**	-0.11	0.4
GOND CASTE	-1.09***	-0.15	0.39
Gond or Hindu RELIGION	0.62	0.04	0.86
Primary occupation is FARMING	-0.44	-0.06	0.41
INCOME[a]	0.00	0.01	0.00
Attended SCHOOL	2.64***	0.25	0.59
AGE	0.02	0.07	0.02
R^2= 0.14			

*P < 0.10, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
**P < 0.05, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
***P < 0.01, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
[a] Gross total household income level in thousands of Indian rupees (Rs).

The mean indirect impact scale score was 23.7 (SD= 3.95; possible range= 11-33 actual range= 13-31), indicating that, overall, locals were experiencing an above average amount and/or severity of indirect impacts from human tiger conflict (Table 3). LIVESTOCK ATTACKED, FARMING, and AGE were all predictors of indirect impacts (Table 7). Older participants experienced more indirect impacts than others, as AGE was strongly negatively correlated with attitude towards tigers. LIVESTOCK ATTACKED and FARMING were positively correlated; LIVESTOCK ATTACKED was strongly positively correlated with attitude towards tigers. This positive correlation meant that

participants who previously had their livestock attacked by a tiger and were primarily farmers had experienced more indirect impacts of tiger conflict than others.

Table 7. Estimated coefficients, standardized coefficients, and standard errors of a model predicting whether participants experienced overall **indirect impacts** from a questionnaire administered to KNP locals from 54 villages (Feb–May 2018).

Variable	Coeff.	Standardized Coeff.	SE
Constant	22.84	-	1.69
Collects FOREST PRODUCTS	0.21	0.24	0.55
GUARDS their LIVESTOCK	0.58	0.05	0.71
LIVESTOCK have been ATTACKED by a tiger	0.84*	0.10	0.48
GENDER	0.6	0.08	0.49
GOND CASTE	0.31	0.04	0.48
Gond or Hindu RELIGION	1.18	0.07	1.05
Primary occupation is FARMING	1.11**	0.14	0.5
INCOME[a]	0.00	-0.03	0.00
Attended SCHOOL	-1.02	-0.09	0.70
AGE	-0.04*	-0.12	0.02
R^2=0.067			

*P < 0.10, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
**P < 0.05, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
***P < 0.01, indicating significant difference between means from Independent Samples T-test and sig. (1-tailed).
[a] Gross total household income level in thousands of Indian rupees (Rs)

Discussion

Our research adds to the limited literature addressing both the direct and indirect impacts of HTC, and provides a rare quantitative perspective of indirect impacts. Despite 33% of participants experiencing direct impacts, and 100% of participants experiencing indirect impacts, and risk of attack being perceived as higher than known risk, attitudes towards tigers were positive, overall. We theorize that positive attitudes persist because of a prevailing national pride for tigers, or the emotional investment in tigers, religion,

culture. Also, it could be due to a lack of awareness of the connection between conflict and indirect impacts. Alternatively, this could be due to social desirability bias, where participants may be telling us what they think we want to hear, so they appear more favorable in our eyes.

Knowledge

Despite our participants living in close proximity to tigers, and 49.7% of participants having seen a tiger, our results suggest that seeing or living near tigers does not necessarily result in a higher level of knowledge of tigers. Certain demographics, however, did exhibit a higher level of knowledge of tigers than others. Pastoralists and livestock guards may be repeatedly exposed to wildlife while caring for their livestock during grazing (Mmassy and Røskaft 2013), which may explain why our results showed a higher level of knowledge of tigers.

Of participants not in the Gond caste, only 4% of participants were in a caste that is considered to be lower than the Gond caste, while 96% were in a caste that is considered to be higher than the Gond caste. More opportunities are often available to those in higher castes which may help explain why members of the Gond caste in our sample had a lower level of knowledge of tigers when compared to others.

Traditional gender roles within local communities may contribute to gender differences relative to knowledge (Røskaft et al. 2004; Røskaft et al. 2003). Males, typically young, in our sample may show higher level of knowledge of tigers because of their different, often risky roles in outdoor activities and responsibilities, such as guarding

livestock and crops (Røskaft et al. 2004; Røskaft et al. 2003), which may require more knowledge to avoid danger. Males' potential exposure to outdoor activities that require knowledge of potential dangers is also reflected in previous research that found that males had a higher level of knowledge of wildlife (Mmassy and Røskaft 2013). Additionally, Kellert (1984) found that males scored a higher knowledge score when the animal was a predator.

Older participants in our sample were more likely to be knowledgeable of tigers as they have spent an inherently longer amount of time living in close proximity to tigers than younger participants. Younger participants may be exposed to wildlife while performing outdoor responsibilities such as forest product collection (Nyhus et al. 2003), however, past research has shown that the amount of time spent around wildlife may be impactful on people's knowledge of wildlife (Mmassy and Røskaft 2013; MacGregor 2000). This finding is congruent with past research by Mmassy and Røskaft (2013) who found that older participants living near the Serengeti had more knowledge of birds in their area than younger participants.

The tendency of farmers to only concern themselves with wildlife species that may help or harm their crops may explain our finding that farmers had a lower level of knowledge of tigers. Herzon and Mikk (2007) found that while farmers were interested in learning about wildlife, they mostly concerned themselves with species that were useful or harmful to farming. Given that tiger attacks do not often occur in agricultural fields (Miller et al. 2016a), farmers in our sample may not concern themselves less with tigers than other wildlife that crop-raid.

Introducing an educational program to augment the knowledge of younger, female, and others who may not be directly involved with HTC would help ensure that more people around KNP are knowledgeable of tigers, and other species, in their area. With the establishment of "Kanha Bhoorsingh Playschool" which encourages children to learn about wildlife in their area, KNP has already begun to educate locals about wildlife (Dixit 2018). This program could be expanded to include behavior and ecology of KNP wildlife as well as including women of all ages.

Attitudes

Although fewer than 5% of our participants received monetary benefits of direct employment by KNP (i.e., park or hotel jobs), attitudes towards tigers were positive overall, with membership to certain groups exhibiting more positive attitudes. In KNP the compensation program is critical to reducing retaliation (Miller et al. 2016b) and compensation programs have been shown to increase trust in government officials and directly impact attitudes towards conservation (Dickman et al. 2010). The success of the compensation program in KNP and the fact that men are often responsible for the livestock and filing for compensation following a conflict incident (Ogra 2008) may explain our result for males having more positive attitudes towards tigers. Our result is consistent with past research that indicated that gender tends to influence locals' attitudes towards tigers (Bhatia et al. 2017).

Given that the Gond caste is an indigenous ethnic group and members have lived near or in KNP for their entire lives until compulsorily removed, our finding that

participants in the Gond caste were more likely to have a negative attitude towards tigers may be explained with previous research. Until their villages were relocated outside of the core areas of KNP (Negi and Shukla 2012), the Gond caste has historically been dependent on KNP through forest product collection, livestock grazing, and hunting of wildlife until their villages were relocated outside of the core areas of KNP (Negi and Shukla 2012); the process of relocation may aggravate locals' attitudes (Barua et al. 2012). Struebig et al. (2018) found that attitudes towards wildlife, especially in Southeast Asia, are often tied to certain indigenous ethnic groups. Stories are often passed down between generations (Mmassy and Røskaft 2013) and cultural or religious significance is tied to certain species, which may lead to increased support for conservation (Struebig et al. 2018). This is especially pertinent to our study as tigers are considered to be spiritually important to people and, thus, members of the Gond caste are likely to be more willing to support tiger conservation than members of other castes.

Our result of participants who attended some level of school having more positive attitudes can be explained by the relationship between those that receive education and the resulting reduced fear of and increased tolerance towards wildlife. Lagendijik and Gusset (2008) concluded that as children in rural areas received more education, education helped promote coexistence among humans and tigers. Education can help reduce fear towards wildlife and increase knowledge of wildlife, which in turn may result in more positive attitudes towards wildlife (Lagendijik and Gusset 2008) and improve local's tolerance of wildlife (Romañach et al. 2007; Sillero-Zubiri et al. 2006), explaining

our finding that participants who attended some level of school had more positive attitudes.

Considering specific groups of people and their attitudes towards tigers is important when designing programs to foster relationships between wildlife professionals and locals. In order to foster these relationships, park officials, managers, or future researchers should not only consider the concern of these groups, but strive to incorporate these concerns into future management plans, conservation efforts, or research when possible.

Indirect Impacts

All of the participants in our sample experienced indirect impacts, despite only 32% of participants having experienced a tiger attack on their livestock or themselves, indicating that indirect impacts can be felt without first having experienced a direct impact. Much of the literature on HWC indicates that indirect impacts follow direct impacts from HWC. Bond and Mkutu (2018) and Jadhav and Barua (2012) found that the impacts of HWC on locals do not stop at economic loss, but instead may lead to hidden impacts such as livelihood insecurity or fear. A direct encounter with wildlife has been shown to result in indirect impacts (Mayberry et al. 2017). For example, Mayberry et al. (2017) found that individuals that had been mock charged by an elephant while collecting water were fearful of returning to the area where the encounter occurred. Thus, the relationship between participants who had experienced livestock depredation by a tiger and the indirect impacts they experienced in result is in line with past literature. However,

our results show that indirect impacts are experienced by both people who have and have not experienced direct impacts from HTC. This finding is contrary to much of the previous indirect impacts research by pointing to the prevalence of indirect impacts in KNP and adding to the existing literature on indirect impacts.

Our result that farmers experienced more indirect impacts may be explained by their field's proximity to KNP. Since all of our participants lived within 5 kilometers of KNP, and farm on land directly outside of their village, farmers have an increased vulnerability to experience conflict (Silwal et al. 2016; Negi and Shukla 2012). Furthermore, these farmers are subject to fear and stress associated with potential predator attack by just living and working near predators (Braczkowski et al. 2018).

Our result that those with lower incomes were more likely to experience indirect impacts can be explained by the fact that people must enter the forest to gather forest products for subsistence and income as well as graze their livestock, often fearfully. Mukherjee (2011) reported that diverse incomes lowered locals' dependence on the park, indicating that they would frequent the buffer areas less often for forest product collection and livestock grazing. Reduced dependency, and thus fewer visits, to KNP should thereby reduce risk of tiger conflict within the park, and indirect impacts related to park usage accordingly. Additionally, people from lower income households have less resources available to them to help lessen the impact of hardship. Mulia and Zimore (2012) found that those that were from low income, especially racial/ethnic minority, households experienced high levels of stress and turned to alcohol to deal with it.

Many indirect impacts are associated with livestock or crop guarding (Barua et al. 2013), which makes the groups of people that perform these activities more vulnerable. The expectation of younger people to guard livestock and crops explains our result that younger participants experienced more indirect impacts than older participants. In forest-dependent communities, younger people are expected to guard both livestock and crops and perform other high-risk outdoor activities (Røskaft et al. 2003), making them more vulnerable to diseases, deprived of sleep, or, depending on their age, have poor school attendance (Barua et al. 2013).

Our results suggest that locals living near KNP are experiencing indirect impacts from HTC. Professionals working to conserve tigers while mitigating HTC need to be cognizant of the suite of indirect impacts felt in their area and ensure that they provide the appropriate avenues for locals to seek assistance with these impacts.

The shortage of literature related indirect impacts of HWC, and conflict's negative impacts necessitates additional research to gain an adequate understanding of indirect impacts, especially in areas where predators and people coexist. In order to pursue human-predator coexistence, further research is needed to determine the potential resources that locals require to deal with HPC (e.g., health clinics, alternative fuels for cooking, performance payments); resources that can help people mitigate indirect impacts would be especially helpful especially (e.g., malaria prevention medication, mental health clinics).

APPENDICES

Appendix 1

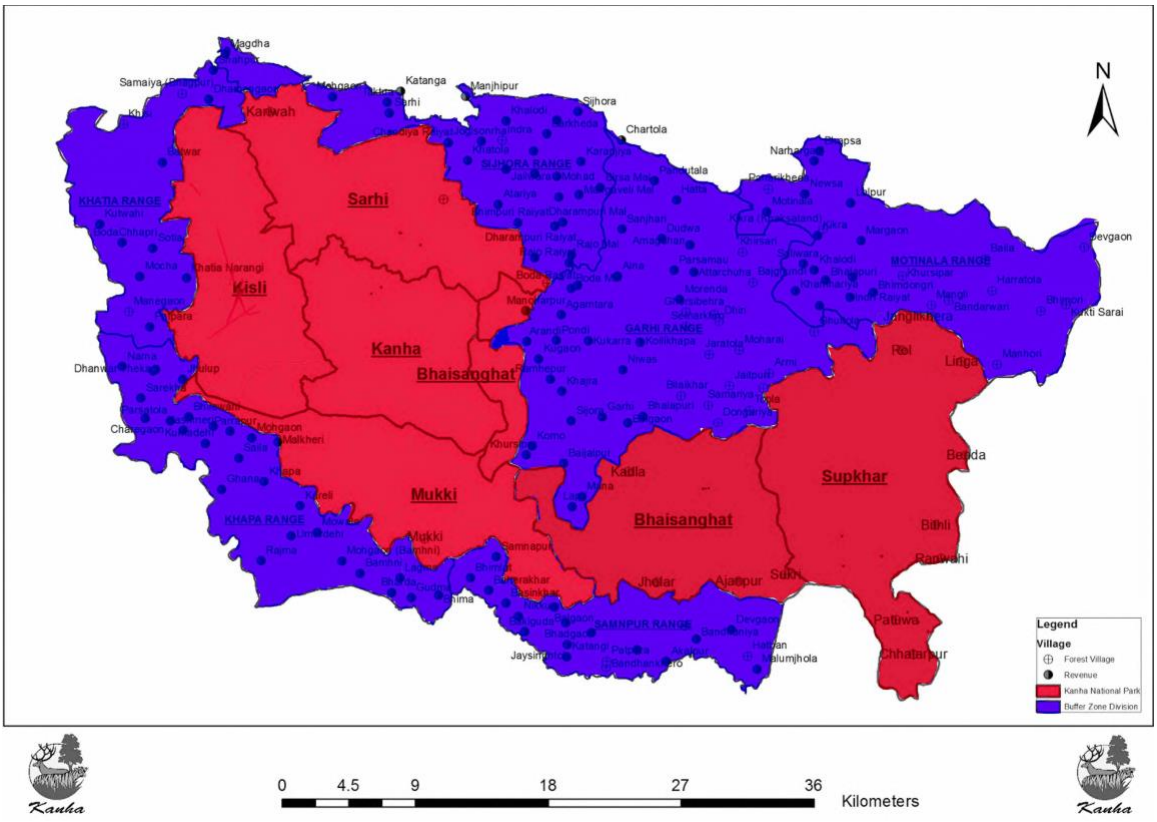

Figure 1.2 The core and buffer areas of Kanha National Park, India.

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